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Indian Standard

ELECTRICAL INSTALLATIONS IN SHIPS

PART 5 SPECIAL FEATURES

Section 4 Control and Instruments — Specification

ICS 47.020.60

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Electrical Equipment and Installations in Ships Sectional Committee, ETD 26

FOREWORD

This Indian Standard (Part 5/Sec 4) was adopted by the Bureau of Indian Standards, after the draft finalized by the Electrical Equipment and Installations in Ships Sectional Committee had been approved by the Electrotechnical Division Council.

While preparing this standard assistance has been derived from IEC Pub 92-504 'Electrical installations in ships — Part 504 : Special features — Control and instruments'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard..

Indian Standard

ELECTRICAL INSTALLATIONS IN SHIPS

PART 5 SPECIAL FEATURES

Section 4 Control and Instruments — Specification

1 SCOPE

This standard deals with electrical and electronic equipment intended for control and instrumentation on board ships. Further this standard under different sections deals with Definitions; General requirements; Environmental and supply conditions and testing, Design; Construction and materials, Installation and ergonomics; Commissioning and testing; and Documentation. Annex A gives the recommendations on electrical fire protection control installations, which are provided for the purpose of fire safety on board ships; Annex B gives the recommendations relating to machinery alarm installations, which are provided in order to give warning of abnormal conditions in ships machinery system; Annex C gives the recommendations relating to automatic control installations for generating sets, which are provided in order to safeguard the electrical power supply while Annex D gives the recommendations relating to automatic starting installations for electrical motor driven auxiliaries such as lubricating oil pumps, cooling water pumps, etc.

SECTION 4A DEFINITIONS

2 GENERAL

The definitions included in this standard are those having special application to the control equipments in ships.

For the definition of general and of more particular terms, reference should be made to:

IS No.	*Title*
IS 1885 (Part 17) : 1979	Electrotechnical vocabulary: Part 17 Switchgear and controlgear (*first revision*)
IS 7118 : 1973	Recommendations for direction of movement for control devices operating electrical apparatus
IS 9000 Series:	Basic environmental testing procedures for electronics components and electronics equipments
IS 10242 (Part 1/ Sec 1) : 1982	Electrical installations in ships: Part 1 General, Section 1 Definitions and general requirement

2.1 Control

Purposeful action on or in a system to meet specified objectives.

2.2 Manual Control

The type of control in which the operator acts on the final controlling device.

2.3 Automatic Control

The type of control in which there is no action of the operator directly on the final controlling device.

2.4 Local Control

Control of an operation from a distance; this involves a link, usually electrical, between the control device and the apparatus to be operated.

2.5 Control Station (Control Position)

A group of components which, by the action of the signals they transmit, determine the set point. Furthermore, a control position will generally enable an operator to verify the achievement of the desired conditions, by means of an appropriate signalling system.

2.6 Centralized Control

Control of all operations of a controlled system from one central control station.

2.7 Automatic Sequence Control

A method in which successive operations are carried out in a sequence either predetermined or resulting from the correct execution of each successive operation.

2.8 Set Point

The value chosen under prescribed conditions for the purpose of adjusting the controller.

If the system has no offset, the set point is identical with the desired value.

2.9 Adjustment

A process by which some parameter (pressure, temperature, current, speed, power, etc) is given a predetermined value.

2.10 Monitoring

The gathering of necessary information concerning the actual operating condition of the system.

2.11 Indicating Instrument

An instrument which indicates, at any time, the instantaneous, effective, average, or peak value of the quantity measured.

2.12 Recording Instrument

An instrument which inscribes or records generally the instantaneous, effective or average values which are successively assumed by the quantity being measured.

SECTION 4B GENERAL REQUIREMENTS

3 OPERATION

Operation of the control equipment should be simple to perform.

4 RELIABILITY

Each apparatus should posses a degree of reliability in accordance with the importance of the control system of which it forms part.

5 SAFEGUARDING

The design of the control equipment should be such that a failure in the control equipment will lead to the least dangerous condition of the controlled process and furthermore such failure should not render any reserve automatic or manual control or both, inoperative.

6 SUPPLY ARRANGEMENT

As far as practicable, control and instrumentation circuits and their supply arrangements should be so designed that failure of the power supply does not damage the installation nor endanger the ship.

7 STABILITY

Each automatic control system, together with its controlled process, should be stable throughout its range of operation.

8 REPEATABILITY AND ACCURACY

The repeatability and accuracy of instruments and control equipment should be adequate for their proposed use and should be maintained at their specified value during their expected lifetime and normal operative use.

SECTION 4C ENVIRONMENTAL AND SUPPLY CONDITIONS AND TESTING

9 GENERAL CONDITIONS

The electrical and electronic control equipment should be suitable for the normal conditions encountered on board ships, for example salt air, moisture, cargo dust, oil-laden atmosphere and mould.

These conditions do not apply to such electrical equipment the ambient conditions of which have been described in other chapters of parts of IS 10242.

10 AMBIENT AIR TEMPERATURE

All control equipment should operate satisfactorily at an ambient air temperature range of 0°C to 55°C and should withstand without deterioration, whilst in operation, air temperature peaks of up to 70°C.

Where extreme ambient temperatures are expected to exist, for example positions directly adjacent to engines, boilers, etc, special consideration should be given.

When equipment is located in panels or cubicles, consideration should be given to the temperature rise inside those panels due to the dissipation of heat from its own components. Consideration should also be given to extra temperature rises due to radiation from hot machinery parts or from the sun.

At locations where low temperature may occur, for example on open decks etc, the equipment should be capable of operating satisfactorily at temperatures down to –25°C.

11 HUMIDITY

All control equipment should operate saftisfactorily under the

- 100 percent relative humidity at temperatures up to 40°C.
- 70 percent relative humidity at all higher temperatures.

12 ACOUSTICAL NOISE

Consideration should be given to the influence of acoustical noise on the control equipment.

13 VIBRATION

All control equipment should operate satisfactorily under the following vibration conditions:

- 2.0 Hz to 13.2 Hz displacement ampliture ±1.0 mm.
- 13.2 Hz to 80.0 Hz, acceleration amplitude (±0.7 g) $\pm 0.7 m/s^2$.
  Maximum acceleration (±0.7 g) $\pm 0.7 m/s^2$.

The natural frequencies of equipment, suspension and supports including individual parts, should not lie within the 0 Hz to 80 Hz range.

If the natural frequencies cannot be kept outside the specified range by constructional design methods, the vibration should be damped so that undue amplification can be avoided.

At special localities for example direct on engines, diesel exhaust pipes, etc, where more severe vibration may be expected, special care should be taken to ensure the ability of the control devices to withstand the conditions satisfactorily at each individual place.

The following values should be considered:

i) On all diesel engines, diesel generator sets, compressors and in the steering gear compartment:
   - — 2.0 Hz to 25.0 Hz, displacement amplitude ±1.6 mm.
   - — 25.0 Hz to 100.0 Hz, acceleration amplidute (±4.0 g) ±40 m/s^2.
     Maximum acceleration (±4.0 g) ±40 m/s^2.

ii) Vibration and acceleration levels on diesel engine exhaust pipes are very severe and vary considerably depending on equipment size and piping arrangement. Measurements on installations indicate that acceleration up to 150 g and frequencies up to 5 000 Hz can be expected.

14 INCLINATION AND MOVEMENT

The control equipment should posses ability to remain fully operational under each of the following inclinations and movements of the ship:

- — inclination in all directions from the mounting position: 22.5°,
- — rolling: 22.5°; 10 s full period,
- — linear vertical acceleration: ± 1.0 g.

15 VOLTAGE AND FREQUENCY VARIATIONS

The control equipment should posses ability to operate satisfactorily at the vibrations from normal values of the electronic power supplies applicable to the location of individual apparatus within the specified limits (*see* Table 1).

Alternating Current:

Table 1 Variations from Nominal Values

	Vibration		
	Permanent		Transient
	percent	percent	Recovery Time, s
Voltage	± 10	± 20	3
Frequency	±5	±10	3

A.C. supplied equipment should be capable of maintaining functional stability and accuracy with input supplies having a possible harmonic content up to 5 percent.

For battery-supplied equipment, voltage variations of +30 percent and –25 percent, as determined by the charging/discharging characteristics, should be taken into account including ripple voltage from the charging device.

When the equipment is not connected to the battery during charging or when voltage stabilizing equipment is used, these values could be reduced to ± 20 percent.

If more severe voltage or frequency variations are expected, special protection of the equipment should be provided.

16 INTERFERENCE

The amount of electrical and electro-magnetic interference on board is very difficult to establish. In order to reduce the effect of interference, the guide lines given in other clauses of this part and IS 10242 (Part 1/Sec 1) should be applied.

17 TESTING

17.1 Tests for environmental conditions are recommended to be carried out according to the test procedures and severities specified in Table 2.

SECTION 4D DESIGN

18 CIRCUIT DESIGN

18.1 Circuits should be designed for easy test, calibration, maintenance and repair. They should preferably be suitable for repair by units or card replacement. In some cases, it may be desirable to provide simulation circuits or similar means to check correct operation of the equipment.

19 TOLERANCES OF CONSTRUCTION PARTS

To achieve the desired objective, the design of any circuit should allow for variation in component data or drift within tolerances specified for the components.

20 MUTUAL EFFECTS

The system design should be such that there will be no undesirable mutual effect between the different circuits. A failure of one component in a circuit should be as far as practicable not lead to failure of components in other circuits.

21 ELECTRICAL SUBDIVISION

Design of circuits should be such that there is no direct connection to any point of the ships main power supply system, for example isolating transformers should be used for power supplies. The chassis may not form part of any circuit.

It is recommended that extensive systems be subdivided and the supplies to the sections be electrically separated or individually protected.

Control circuits should be separated from signalling and indicating circuit. Faults in an indicating lamp circuit are not to impair the operation of the equipment or apparatus.

Table 2 Type Test, Test Procedures and Severities
(*Clause* 17.1)

Sl No.	Test (1)	Procedure According to (2)	Severity for General Application on Board (3)	Severity for Weather-Exposed Areas (4)
1.	Visual	—	Note 1	Note 1
2.	Performance test	—	Note 2	Note 2
3.	Dry heat	IS 9000 (Part 3/ Sec 1)	70 ± 3°C 2h	70 ± 3°C 2h
4.	Accelerated damp heat	IS 9000 (Part 5)	Severity V: 2 cycles, under load	Severity V: 2 cycles, under load
5.	Vibration	IS 9000 (Part 8)	Notes 3 and 5	Notes 3 and 5
6.	Inclination		Inclination, steady, each direction: 22.5°. Rolling, each direction: 22.5°. 10 s full period operation.	Inclination, steady, each direction: 22.5°. Rolling, each direction: 22.5°. 10 s full period operation.
7.	Power supply variation		Note 4	Note 4
8.	Insulation		Before test: For equipment with a nominal supply voltage up to 65 V: test voltage 2 times rated voltage and at least 24 V, an insulation resistance against earth not less than 10 M. For equipment with a nominal supply voltage in excess of 65 V: test voltage 500 V and not less than 100 M. After test: Same values, but 1 M and 10 M respectively. NOTE — Test only on the supply terminals.	Before test: For equipment with a nominal supply voltage up to 65 V: test voltage 2 times rated voltage and at least 24 V, an insulation resistance against earth not less than 10 M. For equipment with a nominal supply voltage in excess of 65 V: test voltage 500 V and not less than 100 M. After test: Same values, but 1 M and 10 M respectively. NOTE — Test only on the supply terminals.
9.	Cold	IS 9000 (Part 2) Test A	—	–25 ± 3°C 2h
10.	Salt mist	IS 9000 (Part 2)	Under consideration whether a salt mist test is necessary in these locations.	Duration 96 h
11.	Damp heat, steady state	IS 9000 (Part 4)		
12.	Damp heat cyclic (12+12 h cycle)	IS 9000 (Part 5/ Sec 1 and 2)		

NOTES

1 Conformance to drawings, design data and complying to general requirements as specified.

2 According to equipment specifications.

3 2.0 Hz to 13.2 Hz: ± 1 mm, 13.2 Hz to 80.0 Hz: ± 0.7 g, Duration: sweeping 90 min, resonance 90 min. Operational.

4 Voltage and frequency variations listed in table below. Performance test should be carried out for each combination 1, 2 and 3. In addition to these tests it should be verified that the equipment functions satisfactorily after a complete supply failure. To test this, the supply should be completely interrupted three times:

Combination No.	*Voltage Variation (Permanent) percent*	*Frequency Variation (Permanent) percent*
1	+ 10	+ 5
2	+ 10	– 5
3	– 10	– 5

	Voltage Transient (Recovery Time 3 s) percent	*Frequency Transient (Recovery Time 3 s) percent*
4	+ 20	+ 10
5	– 20	– 10

5 Vibration test may be carried out on separate samples. Tests number 3, 4, 9, 10, 7 and 8 to be carried out on the same sample.

22 HIGH-INSULATION CIRCUITS

Circuits which depend for their accurate functioning on the maintenance of high-insulation resistance should preferably not be used. If the use of such circuits is inevitable, special precautions should be taken to maintain the high-insulation resistance.

Such special circuits should preferably be provided with means to check the insulation resistance.

23 SIGNAL LEVEL

Signal levels of ship cables should be kept high enough to overcome the effects of contact corrosion, hum and noise pick-up. Transducers and amplifiers should be situated as close to each other as is practicable.

- To avoid possible interference on control and instrumentation cables, the following installation features should where necessary be considered.
- Signal cables should be either screened or twisted pairs or both.
- Balanced input amplifiers are advisable.
- There should be sufficient separation between signal and other cables.

SECTION 4E CONSTRUCTION AND MATERIALS

24 ADJUSTMENTS

The control equipment should be constructed for simple adjustment.

The set points should be retained during vibration by suitable means and should be protected against accidental changing.

25 ACCESSIBILITY

Control equipment should be constructed to permit easy access to the interior parts, and those requiring maintenance should, as far as practicable, be clear of high voltage, high temperature or other unsafe working conditions.

26 REPLACEMENT

Each replaceable assembly should be simple to replace and should be constructed for easy and safe handling.

27 NON-INTERCHANGEABILITY

All replaceable parts should preferably be so arranged that it will not be possible to connect them incorrectly or to use incorrect replacements. Where this is not practicable, the replaceable parts as well as the appertaining plug or similar should be clearly identified.

28 COOLING AIR FAILURE

Apparatus should, preferably, not be dependent on forced air cooling. If forced air cooling is required, the apparatus should be protected against failure of cooling air supply causing dangerous temperature rise in the apparatus.

29 MECHANICAL LOAD ON CONNNECTORS

If plug and socket connections are used, the contacts should not carry any mechanical load, other than is necessary for ensuring satisfactory contact pressure, even when withdrawing or replacing a unit.

Plug-in trays or printed circuit boards should incorporate a retainer to prevent ejection due to shock or vibration.

30 MECHANICAL FEATURES OF CABINETS

Cabinets should be of simple mechanical construction and the need for special tools avoided. All nut and bolt connections should be locked.

31 SHOCK AND VIBRATION ABSORBERS

If anti-shock or anti-vibration mounts are used, adequate clearance should be provided between cabinet and rack to allow full freedom of travel.

Systems with shock or vibration mounts in series should be avoided.

Connecting leads should be arranged so that they do not interfere with the shock and vibration isolation.

32 CABLES AND WIRING

This clause is under consideration.

33 INSULATION OF WIRING

This clause is under consideration.

34 CABLE CONNECTIONS

Terminal boards on control equipment, including transducers, should be so constructed that sufficient space is available to enable cables to be satisfactroily connected, preferably each conductor on its own terminal. All terminals should be clearly identified.

35 VERMIN AND RAT PROTECTION

All cabinets should be vermin and rat proof and openings may require covering with metallic wire mesh of maximum 6 mm square.

SECTION 4F INSTALLATION AND ERGONOMICS

GENERAL

36 LAYOUT

Control rooms should be laid out with due attention to thorough ergonomics for the convenience of the operator and hence the accuracy and safety of the operation.

Area or group identification should be considered especially in complex layouts, for example adequate spacing between display and control groups (horizontal separation is usually better than vertical separation) or marked outlines around each group, or area colour patterns.

37 COMPATIBILITY

The arrangements of indicating instruments and controls should follow a logical sequence.

Where it is desirable, mimic lines can be used.

As far as possible, control motions and the resulting motions of the indicating instruments should be consistent with each other.

38 LABELLING

Each control panel, sub-panel, indicating instrument, control handle, alarm, signal lamp, recording instrument, etc, should be clearly and systematically identified by means of self-explanatory and unambiguous labels (*see* Table 3).

Table 3 Examples of Labelling

– on panels	– controlled area	– main engines
– on sub-panels	– controlled sub-area	– starboard engine
– on indicating and recording instruments	– measured parameter	– lubricating oil temperature
– on instrument dials	– unit of measure	– °C
– on controls	– controlled parameter	– lubricating oil temperature
– on control dials	– effect of motion alarm object	– increase/ decrease
– on alarm groups	– alarm object	– lubricating oil
– on alarms	– cause of alarm	– high temperature

39 LABELS

Labels should be consistently placed relative to instruments, etc, and should be made of durable material, bearing clear and indelible letters and numbers.

40 DISPLAY COLOURS

Colours for differentiation of operating conditions should be readily distinguishable and identifiable.

41 ILLUMINATION

Instruments should be well lit without unintended shadows and glare.

If the surrounding illumination makes it difficult to detect an indicator light, a suitable shade should be provided.

42 AIR CONDITIONING

Consideration should be given to installation of the control equipment in air-conditioned compartments and in any case with due respect to the specified limits of the ambient air temperatures for individual localities.

43 AIR FILTERING

Forced ventilated cabinets in the machinery space or at control positions not separated from the machinery space, should be fitted with suitable air-filters or with a separate supply of clean air.

44 PROTECTION AGAINST FLUID LEAKAGE

Electrical control equipment should not be installed in the same panel or cabinet as equipment employing a hydraulic medium or pipelines carrying water, oil or steam unless effective means have been provided in order to protect the electrical control equipment in case of leakage.

Through-runs of pipe-lines carrying hydraulic mediums, water, oil or steam should be avoided in control rooms.

45 ISOLATION OF CONTROL ROOMS

Deckheads and bulkheads of control rooms should be made sufficienly waterproof to prevent seepage of water, oil, etc, into the compartment.

All cable and pipe entries into control rooms should be suitably filled to prevent steam or oil-laden air being drawn into the compartment.

46 PROTECTION FROM CONDENSATION

As far as practicable, arrangements be made to prevent condensation in enclosures.

47 PROTECTION DURING INSTALLING PERIOD

Control equipment should be well protected during the installing period to prevent damage from welding, caulking, painting and similar injurious operations.

MEASURING INSTRUMENTS

48 INSTRUMENT SIMILARITY

Instruments measuring the same or similar quantities should have the same or similar dial numbering and scale breakdown.

49 DIRECTION OF SCALE VALUES

Scale values should have a methodical sequence, for example increase from left to right, from bottom to top, or clockwise.

50 SCALE DIVISION

Where possible, scales requiring elaborate interpolation should be avoided.

51 AUTOMATIC SEQUENCE CONTROL

Instruments for monitoring an automatic control sequence should preferably display the sequential steps of operation and indicate if the sequential schedule is not being fulfilled.

52 CENTRALIZED CONTROL

Where centralized control can be performed from more than one control position, means should be provided to indicate which control position in operation.

53 DIRECTION OF MOTION

Where applicable, the motion of controls, determined by a person facing the control device, should be as follows:

For an increase in the value of the measured quantity a direction of motion

— "to the right"

or

— "upwards"

or

— "forward"

or, when the movement is chiefly regarded as a rotation.

— "clockwise"

For more detailed instructions *see* IS 7118.

54 CONTROL LEVERS

Control levers, handles and push-buttons should be easy to manipulate.

The need for extreme force should be avoided.

Motions should be limited by noticeable mechanical stops.

Where necessary, protection against inadvertent operation should be fitted.

55 IDENTIFICATION

In addition to identification by labels, consideration should be given to the use of different shapes of control levers and handles for the various functions so that the operator will learn to associate a control function with a particular shape.

ALARM SYSTEMS

56 AUDIBILITY

Acoustic signals should be audible all over the duty area of the responsible operator and be easily distinguishable above the ambient noise level and from other acoustic signals.

When acoustic problems exist, a visual alarm should be added.

57 MUTING OF ACOUSTIC ALARMS

Means of muting an acoustic alarm should be fitted, but operation of this should not extinguish the visual alarm display.

Muting of an acoustic alarm should not prevent other alarms sounding for a subsequent fault condition.

58 VISUAL ALARMS

The character of visual alarms should indicate at least;

- alarm condition,
- acknowledgment of the alarm, and
- fault clearance.

59 ALARM MEMORY

The indication of a fault should be retained until acknowledgment has been carried out.

60 ALARM CUT-OFF

Consideration should be given to make it possible for an alarm circuit to be cut-off to prevent an unintentional alarm actuation, when excessive deviation from the set point occurs as an inherent consequence of the normal procedure of stopping and starting the machinery in question.

The arrangements to comply with this clause should be such that the alarm system is automatically switched on when the subject machinery is in normal operation.

61 SAFETY OF ALARM SYSTEMS

Alarm circuits should as far as possible be of a self-monitoring type, giving alarm in the event of a fault occurring in the alarm circuit itself.

Test facilities for checking the proper function of the electrical alarm circuits including acoustic devices should be provided.

Consideration should be given to provision of means for checking alarm transducers.

Acoustic alarms should not be blocked in case of lamp failure. A lamp test should be provided.

SECTION 4G COMMISSIONING AND TESTING

62 TESTS OF COMPLETED INSTALLATION

Tests should be carried out to ascertain that the control equipment has been correctly installed and is in good working order before being put into service.

After the completion of the installation, the entire control equipment should be tested.

The first operational tests should be performed to adjust and record the operational ability of each individual control system, including associated actuators, transducers, indicating and recording instruments, controllers, alarms and other control items. It also includes operation in, and switching between, all methods of manual or automatic and of local or remote control.

As far as practicable during trials at sea, the entire control systems should be tested for satisfactory operation.

SECTION 4H DOCUMENTATION

63 APPARATUS DESCRIPTION

For each control apparatus, the manufacturer should deliver sufficient information about principles of operation, technical specifications, mounting instructions, required starting up or commissioning procedures, fault-finding procedures, maintenance and repair, as well as lists of the necessary test facilities and replaceable parts.

Sufficient information should be available to enable a complete system description to be prepared.

64 CIRCUIT DIAGRAMS

Circuit diagrams on durable material should, for each individual control apparatus, be prominently displayed in or near to the apparatus to which it refers, or alternatively included in the control system handbook.

SPECIFIC CONTROL AND INSTRUMENTATION INSTALLATIONS

ANNEX A

(*Clause* 1)

FIRE PROTECTION CONTROL INSTALLATIONS

A-1 GENERAL

Such fire protection control installations may include:

- automatic fire detection alarm installations, such as used in unattended machinery spaces, in accommodation spaces, etc.
- control installations for fire extinction, such as the remote stopping equipment for ventilation pumps, remote starting of fire pumps, etc.

A-2 AUTOMATIC FIRE DETECTION ALARM INSTALLATIONS

A-2.1 Type of Detectors

In each individual space, the fire detectors installed should be of a type, or a combination of types, the detecting method of which is compatible with the type of fire to be expected in the space, for example:

- ionization detectors,
- smoke detectors,
- flame detectors,
- thermal detectors, and
- differential thermal detectors.

A-2.2 Indication on the Detector

Each detector should, as far as practicable, have a visible indication to show that it has operated and detected a fire. The indication should continue until the loop has been manually reset.

A-2.3 Detector Loops

The fire detection alarm system may, for easy location, be subdivided into a number of independent loops. Each individual detector loop should cover not more than one fire zone, one watertight zone or one separate compartment in the machinery space.

A-2.4 Fire Alarm Signals

When one or more detectors are activated, this should automatically result in both audible and visual fire alarm signals.

A-2.5 Audible Fire Alarm Signals

The audible fire alarm signal should have a characteristic tone which distinguishes it from other audible signals on board.

A-2.6 Visual Fire Alarm Signals

Each detector loop should be connected to an individual indicator light. The light indicators should be centralized on a fire detection indicator panel.

A-2.7 Self-Monitoring

Each loop should be self-monitoring. A failure resulting from a circuit interruption, short circuit or an earth fault, should cause a fault warning, which, as far as possible, should be distinguishable from the fire alarm signals.

A-2.8 Emergency Source of Power

An emergency source of power warning should be provided for the fire detection alarm system.

A-2.9 Power Supply Failure

Visual and audible fault warnings should be given for failure of power supplies.

A-2.10 Disconnection Loops

Means may be provided to disconnect one or more loops temporarily during certain operations in the machinery space such as fault finding, testing, welding, etc.

In this case means should be provided to ensure the reactivation of the loop, for example, visual indication or the timing of the off position.

A-2.11 Testing

Fire detection alarm systems, including detector loops, detector heads, audible and visual signals, should be capable of being tested to ascertain that the overall performance is satisfactory.

A-3 REMOTE CONTROL INSTALLATIONS FOR FIRE EXTINCTION

A-3.1 Subdivision of Remote Stop Circuits

A-3.1.1 Ventilation fan motors for cargo spaces, machinery spaces, and accommodation spaces should not be connected to the same remote stop circuit.

A-3.1.2 Remote stop circuits for essential main machinery and for their stand-by machinery should be electrically separated.

A-3.2 Resetting of Remote Stop Circuits

The activation of a remote stop circuit, manually initiated, should continue until it is manually reset. When the possibility exists that after resetting, motors may restart automatically, this should be indicated at the remote stop position.

A-3.3 Running Indication of Fire Pump

Where remote start of a fire pump is fitted, running indication should be provided.

A-3.4 Local Control

Failure in a remote control circuit should not prevent local control of, for example, a fire pump.

ANNEX B

(*Clause* 1)

MACHINERY ALARM INSTALLATIONS

B-1 GENERAL

An alarm installation should have the following objectives:

- to direct the attention of personnel to an abnormal condition;
- to help establish the nature and location of the abnormal condition;
- to enable effective, corrective and where possible, precautionary action to be taken; and
- to have acknowledgment of the alarm and the return to normal condition indicated.

B-2 ALARM REQUIREMENTS

B-2.1 Visual and Audible Signals

The alarm conditions should be indicated by both visual and audible signals.

B-2.2 Repeater Alarm Panels

Where repeater alarm panels are required, these should also be provided with both visual and audible signals. These sinals may be common for all or for a group of alarms connected to the machinery alarm installation.

B-2.3 Labelling

At the main control station, each alarm light should clearly indicate the nature of the fault conditions, for example, low lubrication oil pressure. At remote group alarm panels, the alarm light may only indicate a general fault condition.

B-2.4 Acknowledgment

Acknowledgment of the alarm condition should be indicated by an alternation of the visual signal, for example, from flashing to steady light, and should only be possible from the machinery space concerned or the centralized control position associated with that machinery space.

The muting of an audible alarm at a repeater alarm panel should not lead automatically to the acknowledgment of the original at the main control station.

B-3 DISPLAY OF INFORMATION

B-3.1 Group Arrangement

All alarm lights should have been the same colour significance and, together with controls and displayed data, should be arranged in logical groups.

B-3.2 Legibility

The illuminated legend or label belonging to each fault indicator should be clearly visible from the alarm acknowledgment position.

B-3.3 Common Audible Alarm

If the audible alarm signal is also used for other purposes, for example, telegraph, telephone, general alarm, it should be accompanied by luminous call panel(s) indicating the system concerned.

B-3.4 Alarm Differentiation

An existing alarm should not prevent the indication of further faults.

B-3.5 First Failure Indication

In alarm systems for complex machinery installations consideration should be given to means for indicating the first failure.

B-4 SUPPLY ARRANGEMENTS

B-4.1 Stand-by Power Supply

Consideration should be given to the provision of a stand-by power supply for the alarm installation.

B-4.2 Alarm for Supply Failure

Alarm indication should be given for failure of alarm installation power supplies.

B-5 DESIGN

B-5.1 Separation of Functions

Automatic machinery safety shut down and slow down controls should be separated from the alarm installation as far as practicable.

B-5.2 Monitoring Equipment

Alarm installations may be combined with monitoring equipment such as equipment provided with analogue read-outs of measured variables or with data loggers or alarm data printers.

B-5.3 Time Delays

Alarm channels, where necessary, should be provided with suitable time delays.
Transient phenomena such as pressure waves in protected pressure systems, sensor contact bouncing or electromagnetic interference from other systems, should not cause the alarm installation to operate.

All level alarms should have a time delay.

B-5.4 Closed Loops

Normally closed loop systems (continuous circuit) should be used to prevent non-indication of an alarm due to a broken sensor loop.

Alternatively, open loops may be used, if they are monitored for sensor circuit faults.

B-5.5 Earth Fault

Earth fault(s) alarm sensor circuits should cause the alarm to operate, or be indicated by an alternative manner or should otherwise not prevent indication of alarm(s).

B-5.6 Mutual Fault Independence

A fault in any one alarm channel, particularly in the external incoming and outgoing circuit, should, as far as practicable, not influence the normal operation of any other channels.

B-5.7 Acoustic Alarm Independence

A fault in alarm indicating lamps, including short-circuit in lamps or lamp-holder, should not affect the operation of the acoustic alarm.

B-6 SENSORS

B-6.1 Performance

The sensors should give stable, accurate and repeatable performance over a long period of time.

B-6.2 Reliability

Alarm sensors should be mechanically robust, have good mechanical protection and reliable electrical connections.

B-6.3 Site of Sensor

All alarm sensors should be sited so that the sensor output is a realistic measure of the variable for which it is intended to indicate an alarm conditions.

B-6.4 Response Time

Sensors should have a response time compatible with changes in the measured variable.

B-6.5 Enclosure

The enclosure of alarm sensors and their terminal boxes should be adequate for the expected place of installation and for the type of cable installed.

B-7 PARTICULAR ALARM MATTERS

B-7.1 Flooding Zone Indication

If flooding alarm sensors have been installed in separate compartments, the alarm arrangement should indicate the compartment in which the fault has occurred.

B-7.2 Engine Room Telegraphs or Similar Devices

In the event of failure of supply to the engine room telegraph or similar devices, an indication should be given on the bridge.

ANNEX C

(*Clause* 1)

AUTOMATIC CONTROL INSTALLATIONS FOR ELECTRICAL POWER SUPPLY

C-1 GENERAL

Such automatic control system for generating sets may include:

- automatic starting of a set,
- automatic connecting into a dead bus bar,
- automatic paralleling,
- automatic shut down of a set,
- automatic disconnecting of non-essential services, and
- automatic analysis of power reserve.

C-2 AUTOMATIC STARTING

C-2.1 Initiation of Starting Orders

Orders for automatic starting may be given, for example by:

- no voltage (blackout),
- prolonged voltage drop,
- overvoltage,
- prolonged frequency drop,
- overvoltage,
- prolonged frequency drop,
- expected frequency reduction or expected stop of running set,
- overload (mechanical or electrical or both),
- increase of power demand,
- failure of running sets,
- pressure drop in exhaust gas boilers, and
- remote manual means.

C-2.2 Delay of Signal

In order to avoid inadvertent starting, signals caused by transient conditions, for example high motor starting currents, should not cause the automatic starting of a set.

C-2.3 Transfer of Starting Order

If more than one set is fitted with automatic starting devices, consideration should be given to fit either a sequence system, which, in case of starting failure, automatically transfers the starting order to the next set(s), or a selector switch for manual use.

C-2.4 Pre-starting Conditions

Means should be provided to ensure that proper starting and running conditions exist at any time regarding starting air, fuel, cooling water, etc.

C-2.5 Stand-by indication should be arranged at the control panel and consideration should be given to safeguarding personnel at the machines, for example, by local stand-by indication.

C-2.6 Starting Interlock

Every set should be capable of being interlocked against inadvertent starting, in order that maintenance and repair may be carried out in safety.

C-2.7 Start Indication and Restriction

C-2.7.1 The automatic starting and running of a set should be indicated.

C-2.7.2 Means should be provided to limit the number and the duration of starting attempts in case of starting failure.

C-2.7.3 Starting failure of a set should give an alarm signal.

C-3 AUTOMATIC CONNECTING ONTO A DEAD BUS BAR

C-3.1 Connection at Blackout

It should be ensured, when closing a generator circuit breaker onto a bus bar, that the generator voltage is sufficiently high.

In order that the initial load will not exceed the capability of the generator, consideration should be given to limiting or sequencing the re-connection of the loads or both.

C-3.2 Non-simultaneous Closing

Precautions should be taken to avoid simultaneous automatic closing of two or more generator circuit breakers.

C-3.3 Undue Closing

Care should be taken to prevent undue automatic closing of the generator circuit breaker in the event of interrupted supply to the starting order sensing element, such as a low voltage relay.

C-3.4 Short-Circuit

After a blackout due to short-circuit conditions, no generator circuit breaker should be permitted more than one automatic closing attempt.

C-3.5 Disconnecting of Running Set

If a set has been started due to a prolonged voltage or frequency drop not directly causing a running generator to trip, consideration should be given to having the faulty generator set disconnected as soon as the stand-by set is ready for taking over.

C-4 AUTOMATIC PARALLELING

C-4.1 Required Conditions

In order to achieve automatic paralleling, it will be necessary to have efficient automatic synchronizing and automatic closure of the circuit breaker.

Automatic load sharing may also be necessary.

NOTE — Attention is drawn to the possibility of fast frequency fluctuations occuring due to heavy load rushes. Where this may be expected, the use of quick closing circuit breakers, or synchronizing reactors, or similar means should be considered.

C-4.2 Disconnecting of a Running Set

If a set has been started due to a bus bar voltage or frequency drop to a level not permitting synchronization, the connected generator should be automatically disconnected as soon as the stand-by set is ready for taking over.

C-5 AUTOMATIC SHUT DOWN

C-5.1 Initiation of Shut Down

Failures which might cause damage to a set should, as far as practical, automatically disconnect and shut down the set concerned, for example over speed, low pressure of lubrication oil, low vacuum.

C-5.2 Prediction Alarm

In order to prevent unnecessary shut down, consideration should be given to the provision of an additional alarm signal, before the dangerous value is reached, thus allowing manual precautions to be taken.

C-5.3 Shut Down Due to Decrease of Load

In systems with automatic starting due to increase of load, consideration should be given to delayed shut down upon decrease of load.

C-5.4 Sets Cooling Down

Where necessary or desired, a running out sequence may be programmed permitting the set to smooth the thermal-mechanical effects of sudden change from high to no load.

C-5.5 Indication of Shut Down

Automatic shut down of a set due to a failure should cause an alarm signal.

C-5.6 Prevention of Restarting

Automatic restarting of a set after an automatic stop due to a failure should be prevented.

C-5.7 Power Supply

The power supply should be taken from an independent source, for example, a battery. Consideration should be given to providing visual and audible alarm indication that the power supply has failed.

C-6 AUTOMATIC DISCONNECTING OF ON-ESSENTIAL SERVICES

C-6.1 Causes of Disconnecting

In order to safeguard electrical power supply for essential services, the provision of a system to disconnect automatically non-essential services should be considered in the following cases:

- when one generating set is normally used to supply the electrical load, but where the possibility exists that due to the automatic switching on of additional loads, the total load exceeds the rated generator capacity; and
- when generators are operated in parallel to supply the load and when in case of failure of one of the running generator's, the total load exceeds the combined capacity of the remaining generator(s).

C-6.2 Design Conditions

When designing the protection system to trip the non-essential services in case of generator overload, due account should be taken of loads with power factors deviating from rated values, the decreased efficiency of engines, etc.

In order to safeguard the electrical power supply in such cases, consideration should also be given to provide, for example, low-frequency relays in addition to generator current relays.

ANNEX D

(*Clause* 1)

AUTOMATIC STARTING INSTALLATIONS FOR ELECTRICAL MOTOR DRIVEN AUXILIARIES

D-1 GENERAL

All equipment employed in automatic starting installations for electrical motor driven auxiliaries should, where applicable, comply with the recommendations of Switchgear, Electrical Protection, Distribution and Controlgear.

D-2 AUTOMATIC SEQUENCE STARTING

D-2.1 Prevention of Overload

Controlgear used for the automatic restart of electrical motors should, where necessary, be provided with an automatic sequence starting system to prevent overloading of the generating equipment at the moment and during the procedure of power restoration after occurrence of a blackout.

D-2.2 Starting Delays

The sequence starting system when provided should ensure the shortest possible starting delay for those auxiliaries which are not vital for the ship or its propulsion machinery, such as steering gear motors and lubricating oil pumps.

D-2.3 Interlock System

If the rating of motors is such that more than one generating set, should be connected to the supply system before the motors may start automatically, an interlock system should be provided.

D-3 STARTING INSTALLATIONS FOR STAND-BY AUXILIARIES

D-3.1 Starting Order

The starting order for the stand-by machine should be given either from the controlled medium or the electrical system, or both, as appropriate for the service concerned. The starting order for a stand-by lubricating oil pump motor, for example, should be taken from the lubricating oil, pressure, flow or gravity tank level, depending on the system design and, lubricating oil pump motor.

D-3.2 Stand-by Indication

Selection of the stand-by position for an electrical motor driven auxiliary should, together with the state of readiness of its power supply, be properly indicated.

D-3.3 Indication of Start

Automatic starting a stand-by auxiliary should cause an alarm signal.

D-4 CONTROL VOLTAGES

The voltage of control circuits incorporating sensing elements, such as pressure sensors or similar devices mounted in the ship's machinery equipment, should not exceed 250 V d.c. and a.c.

D-5 MANUAL CONTROL

A fault in the controlgear or one motor or in the automatic change over system for running or stand-by motors should not render more than one motor unfit for manual control.

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